

Analysis of Liquid Tin Surfaces

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Outline

- PMI effects at liquid tin surfaces
- Surface composition data on liquid tin
- Adsorption of deuterium on liquid tin
- Summary



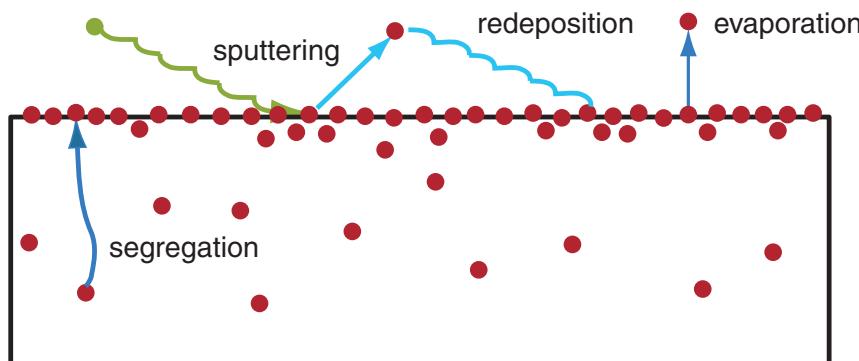
Surface studies of plasma-facing liquids

Issue: What comprises the surface seen by the plasma?

Need: Experimental data on liquid surfaces needed to properly model conditions that will exist in a fusion reactor.

Tasks:

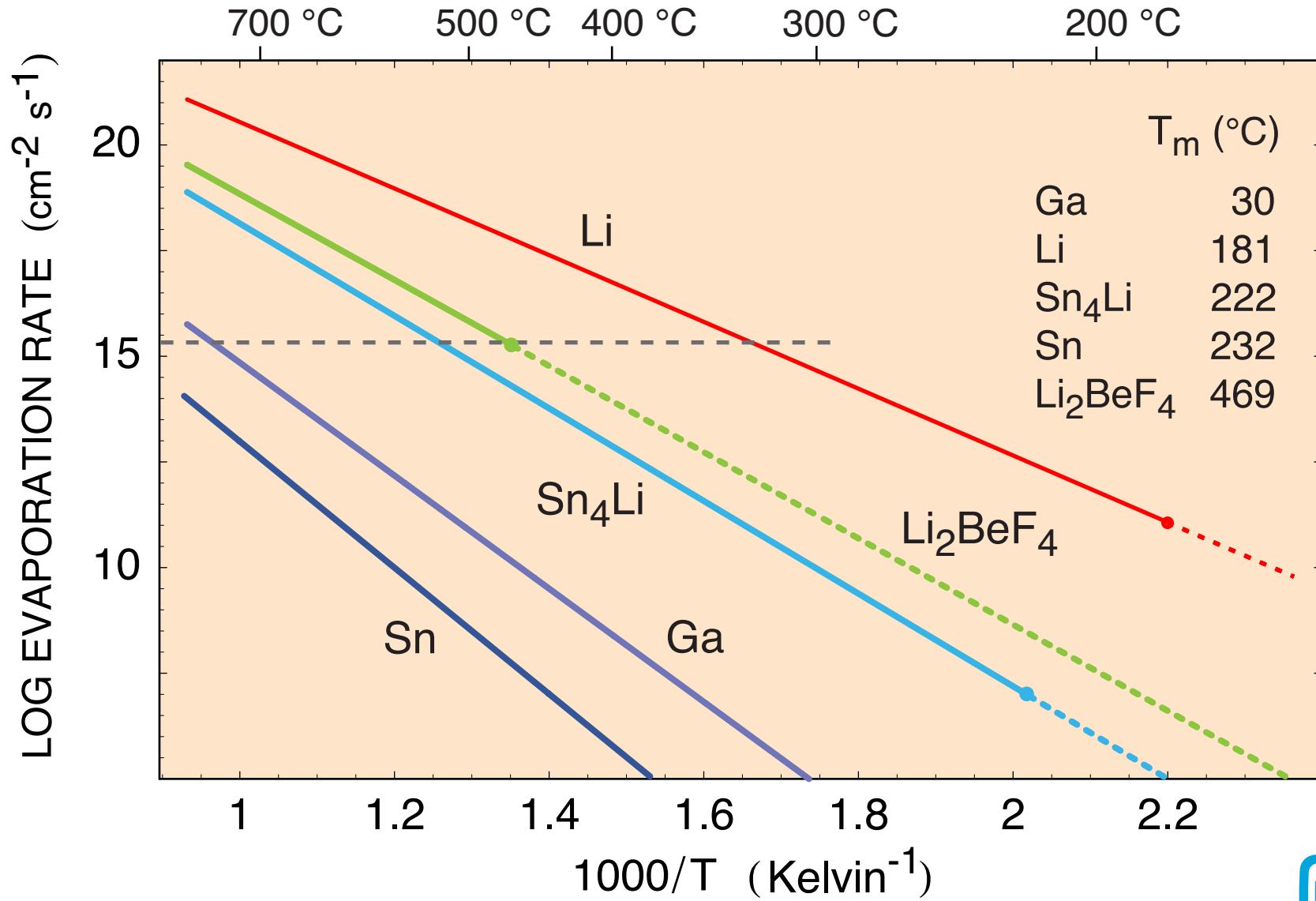
- Examine surface composition of candidate liquids
- Consider how surface composition will evolve during plasma exposure due to combined effects of:



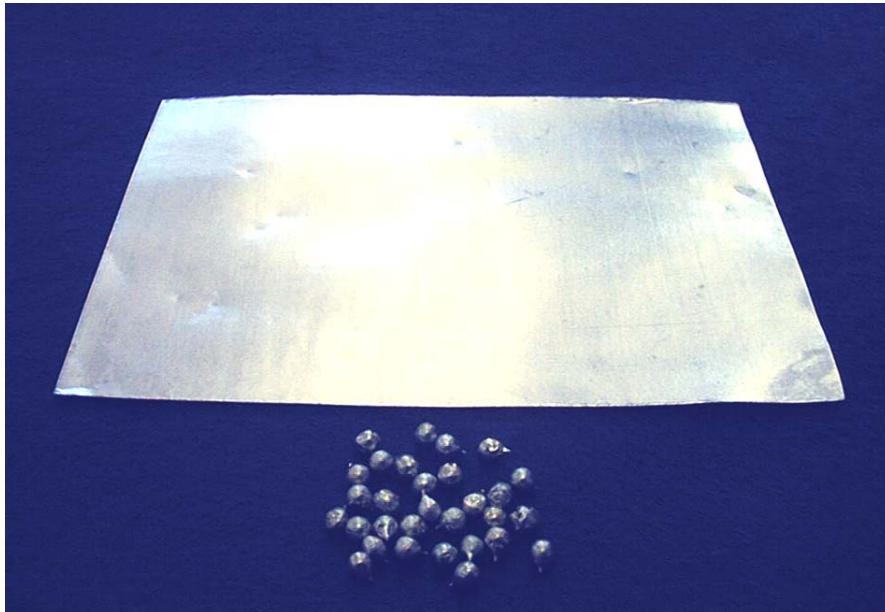
- > evaporation
- > sputtering / redeposition
- > segregation.



Evaporation rates for candidate liquids



Tin is air stable – its oxide is protective.



- Tin is relatively unreactive and easy to handle.
- Purities in excess of 99.9% are readily available.
- An abundant element with ten stable isotopes.

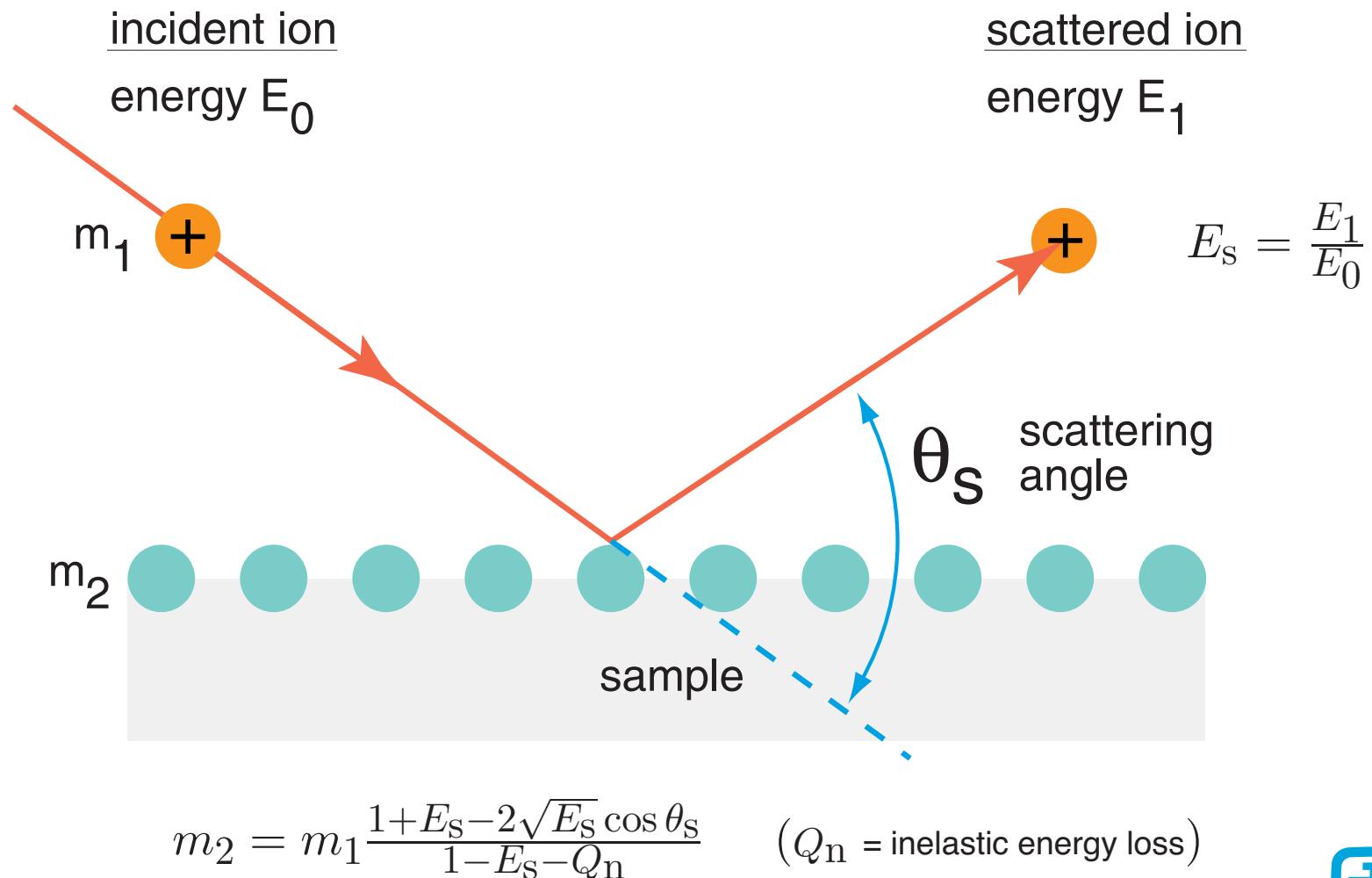


Surface analysis of liquid tin

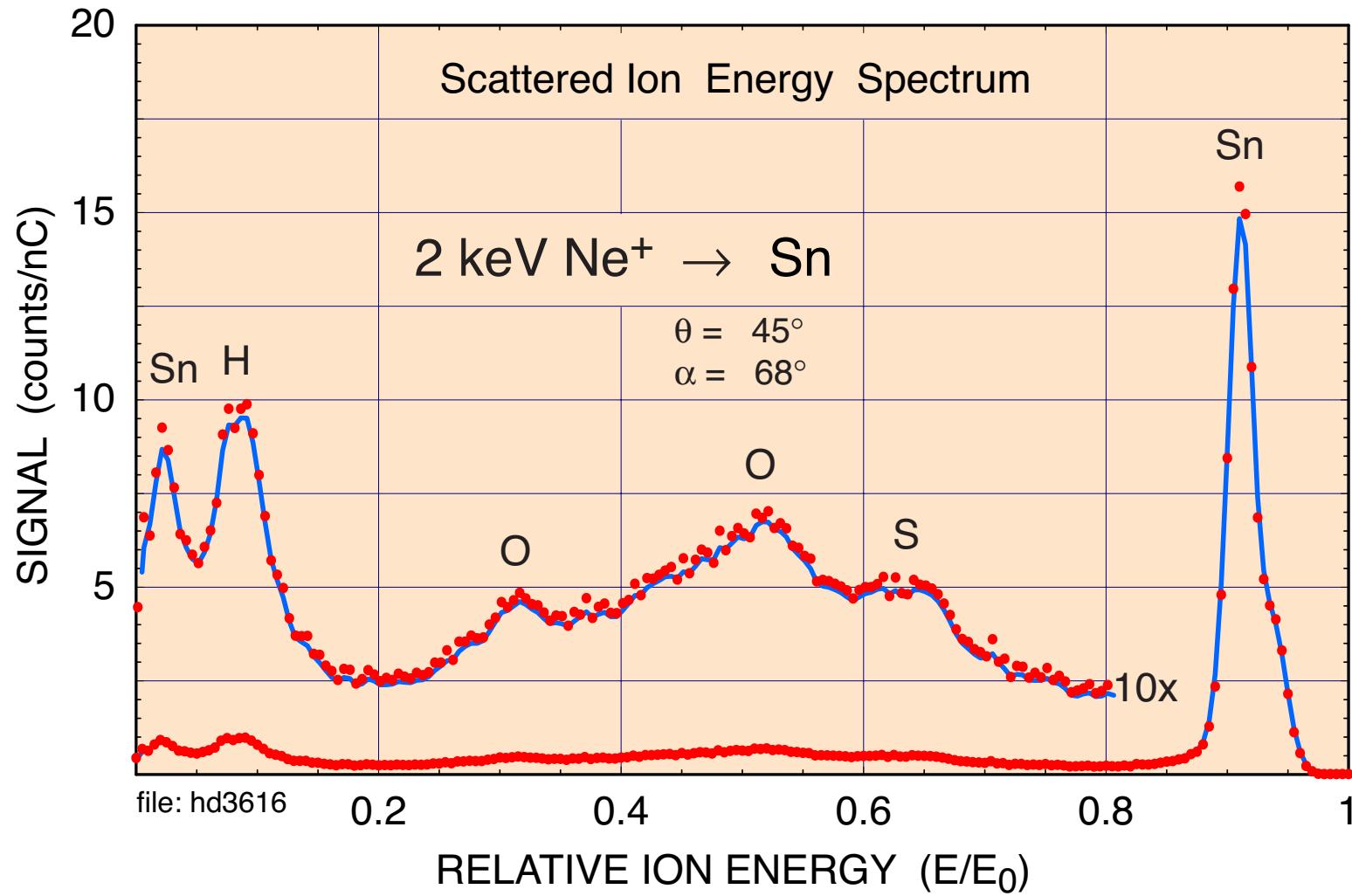
- Liquid Sn was prepared by melting high-purity Sn foil (99.99+%) in vacuum.
- The composition of the liquid Sn surface was measured using ion beam probes:
 - low-energy ion scattering (LEIS)
 - direct recoil spectroscopy (DRS).
- Surface composition measurements were obtained from 25 °C up to 800 °C.
- The liquid Sn surface composition was monitored during exposure to D₂(g).



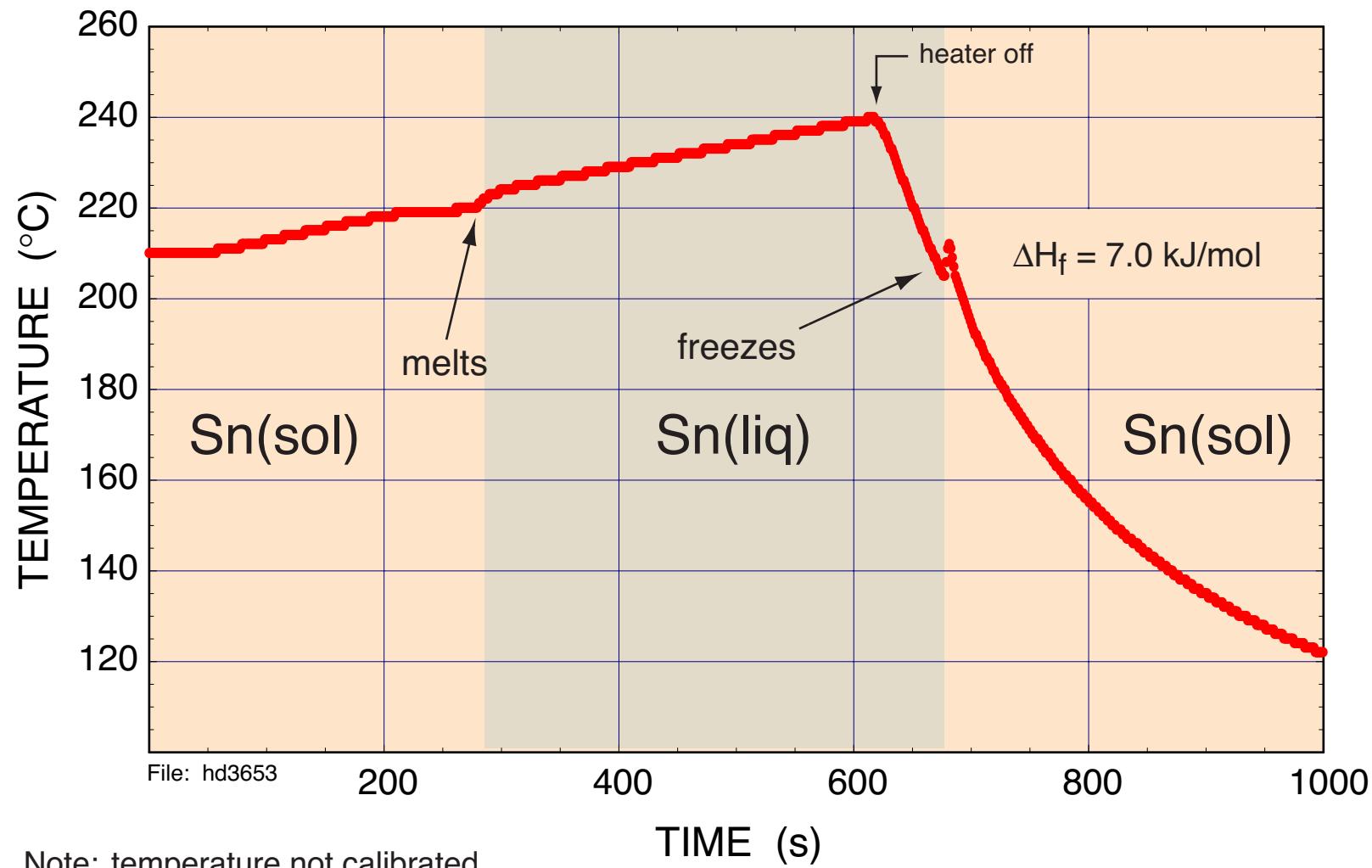
Surface measurements consist of aiming a monoenergetic ion beam at a surface and measuring the energy loss of reflected ions.



Unmelted Sn surface shows some contamination.



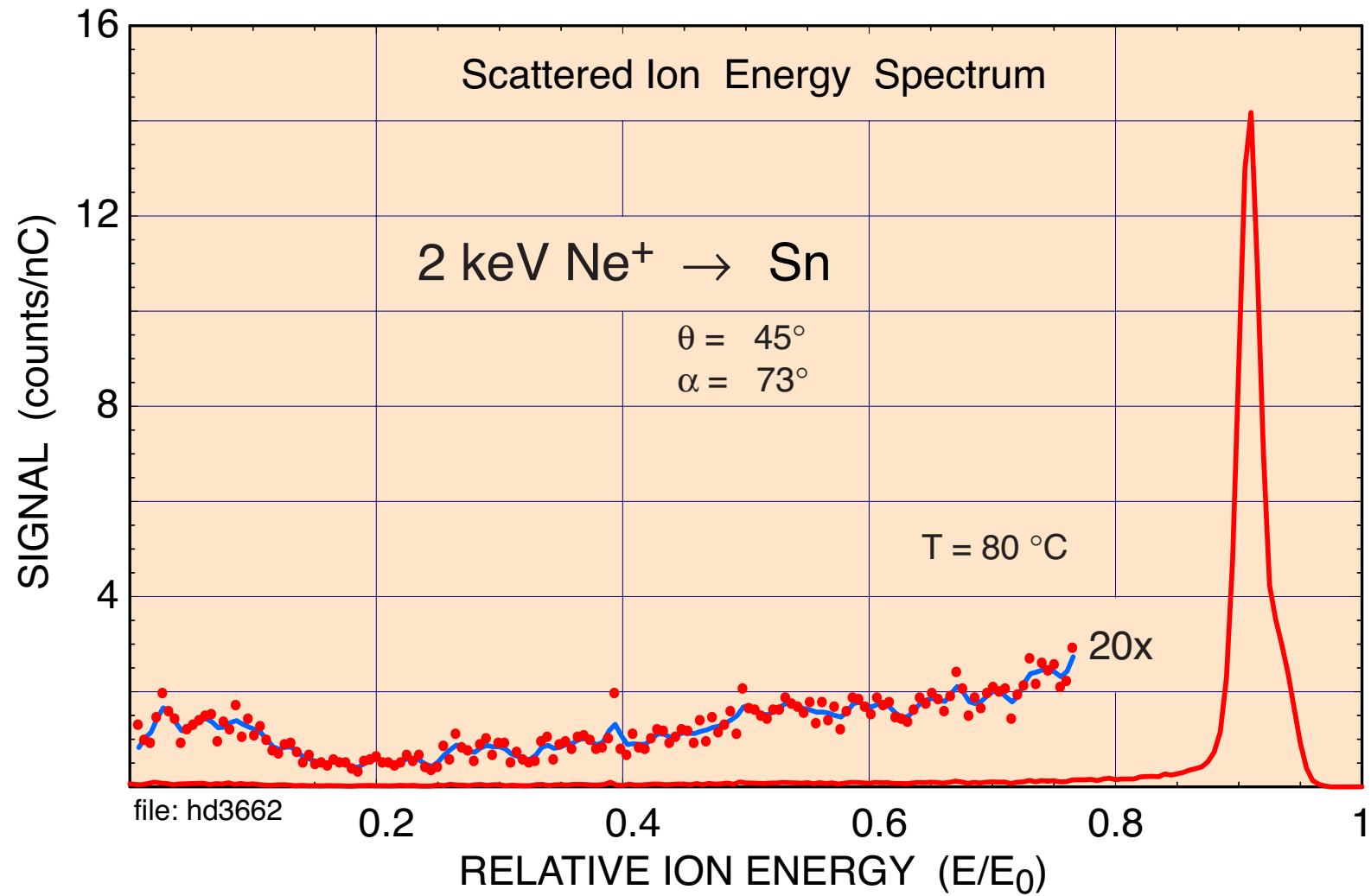
Sn phase changes seen during heat cycle.



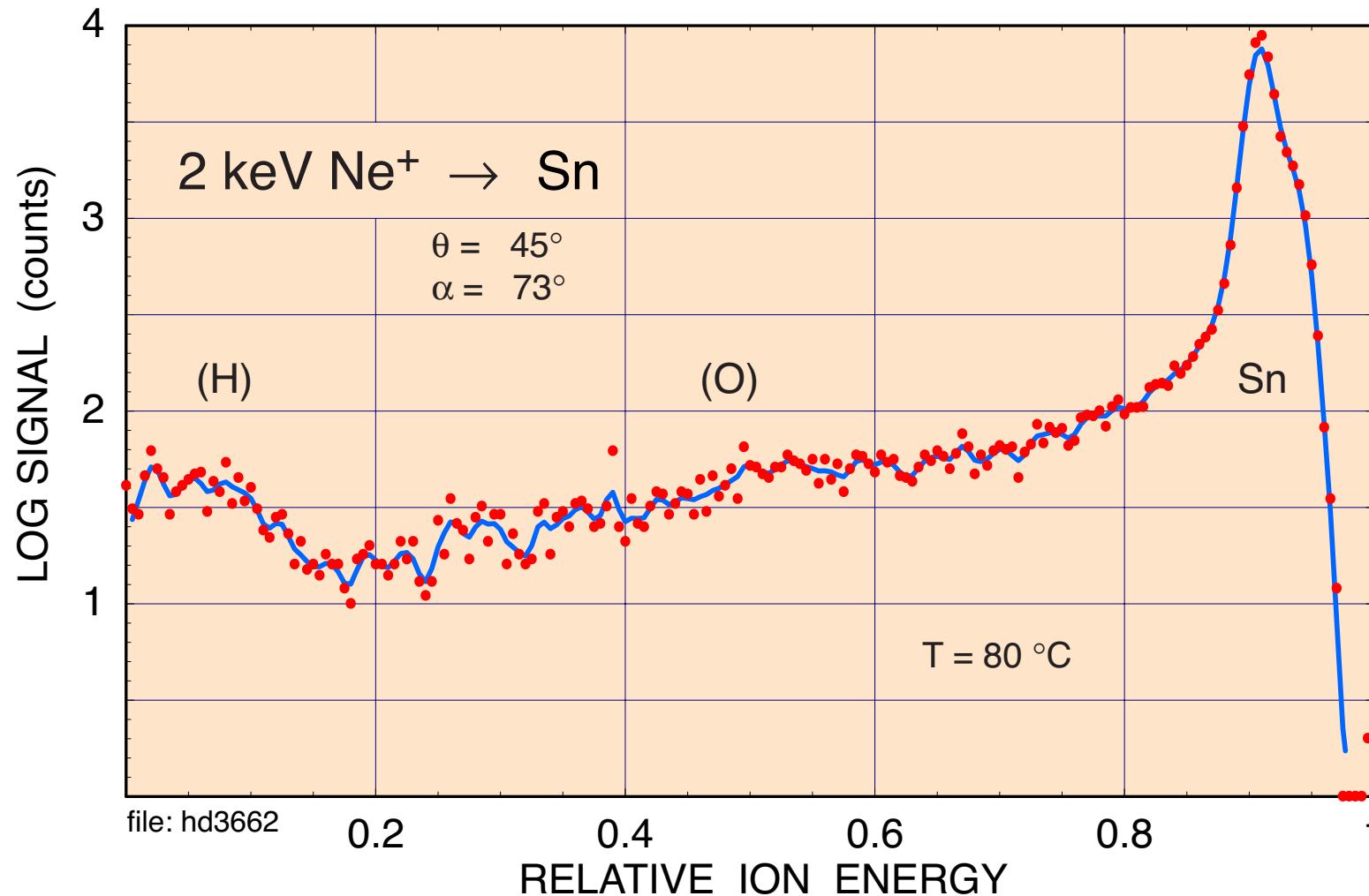
Note: temperature not calibrated.



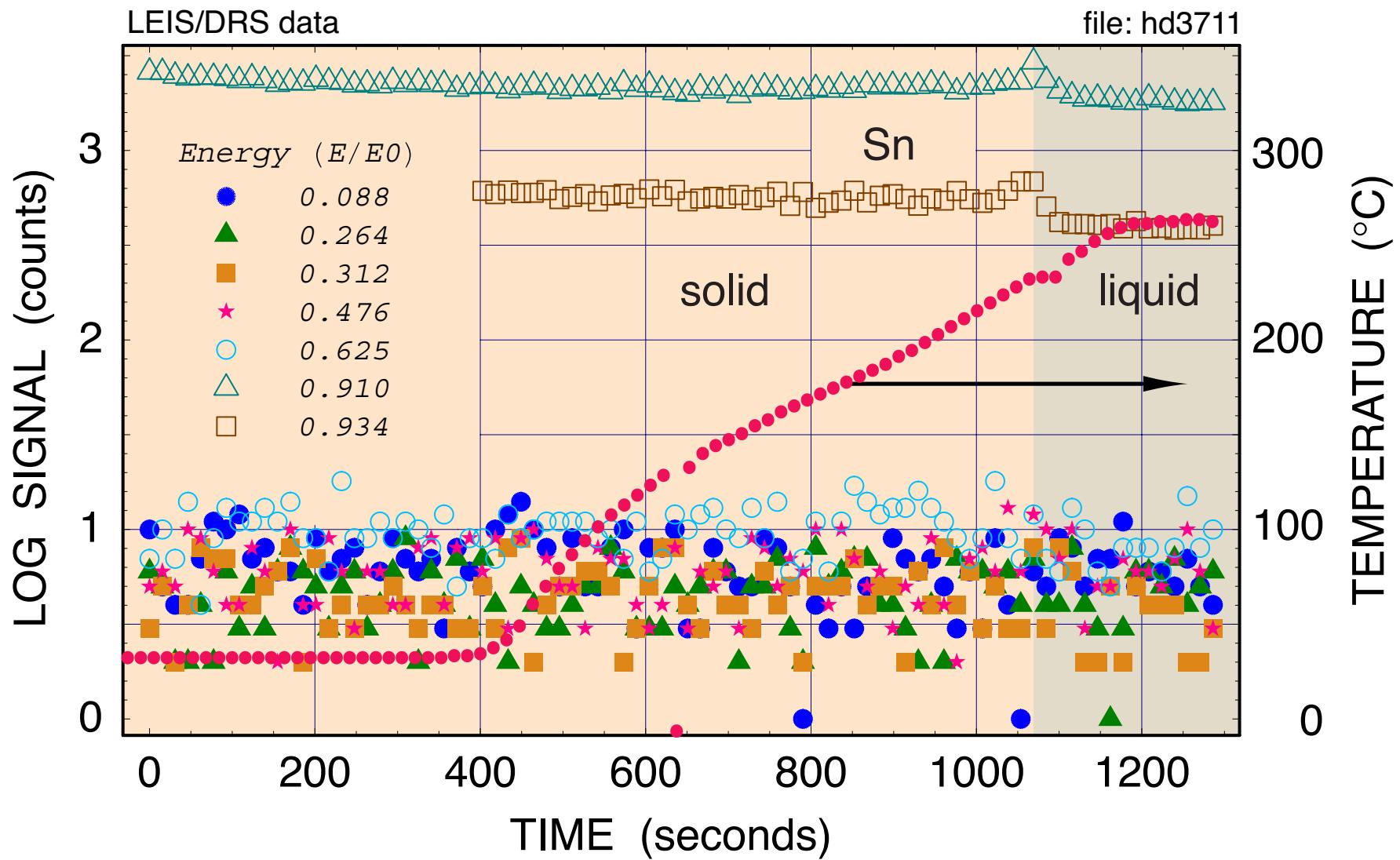
Surface of resolidified tin in vacuum is clean.



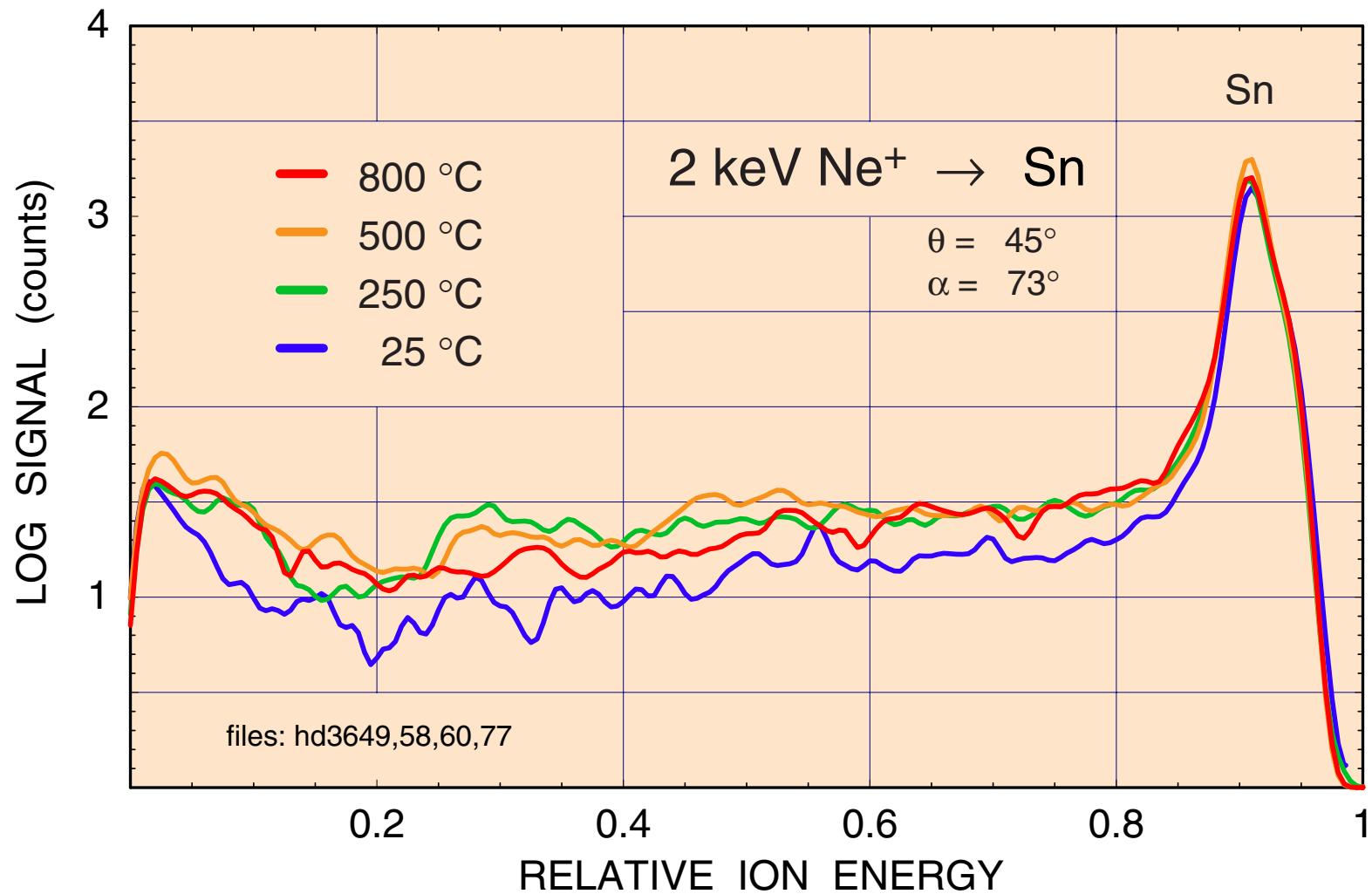
Very little adsorbed H or O is detected on resolidified Sn.



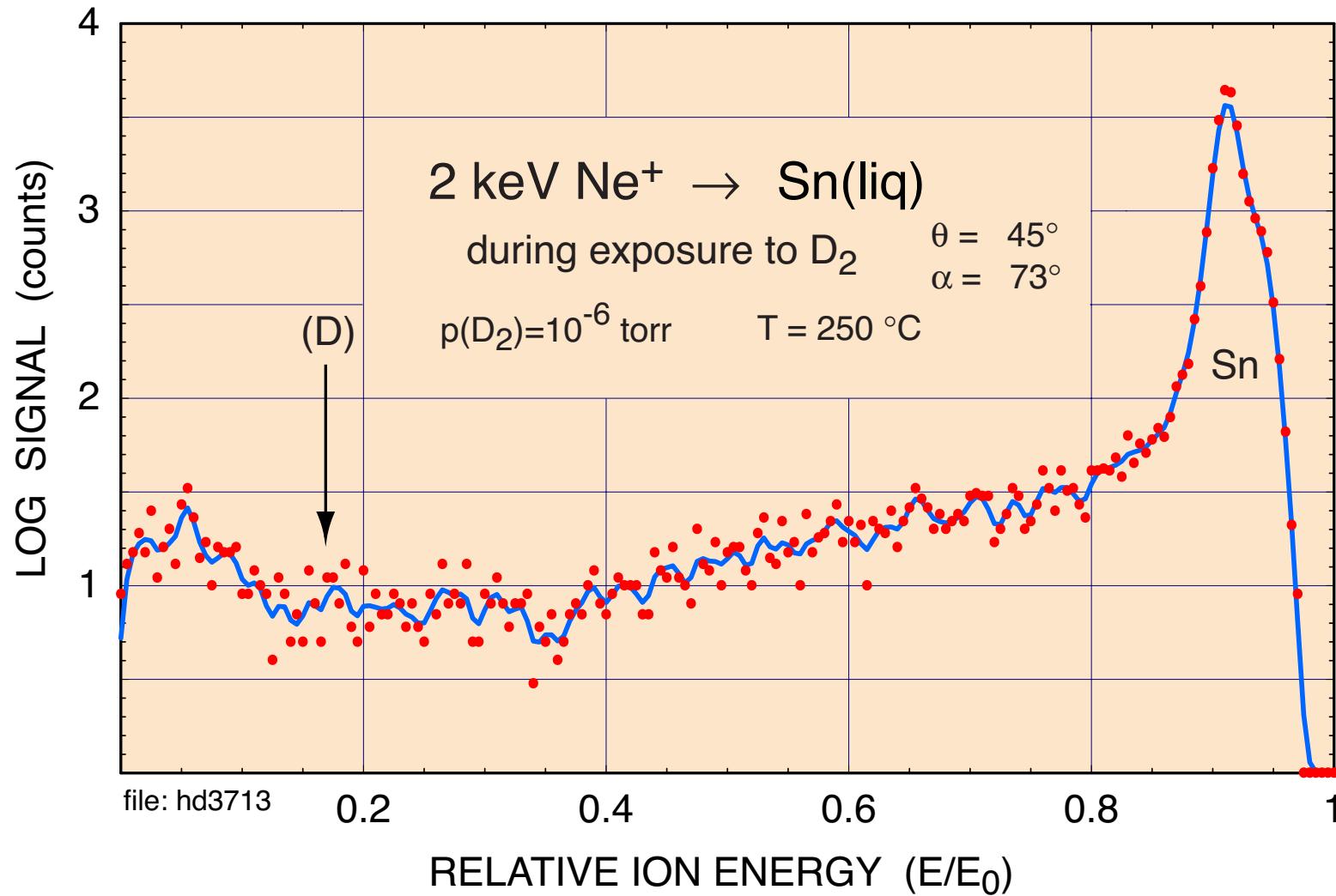
Impurity levels remain low when Sn melts.



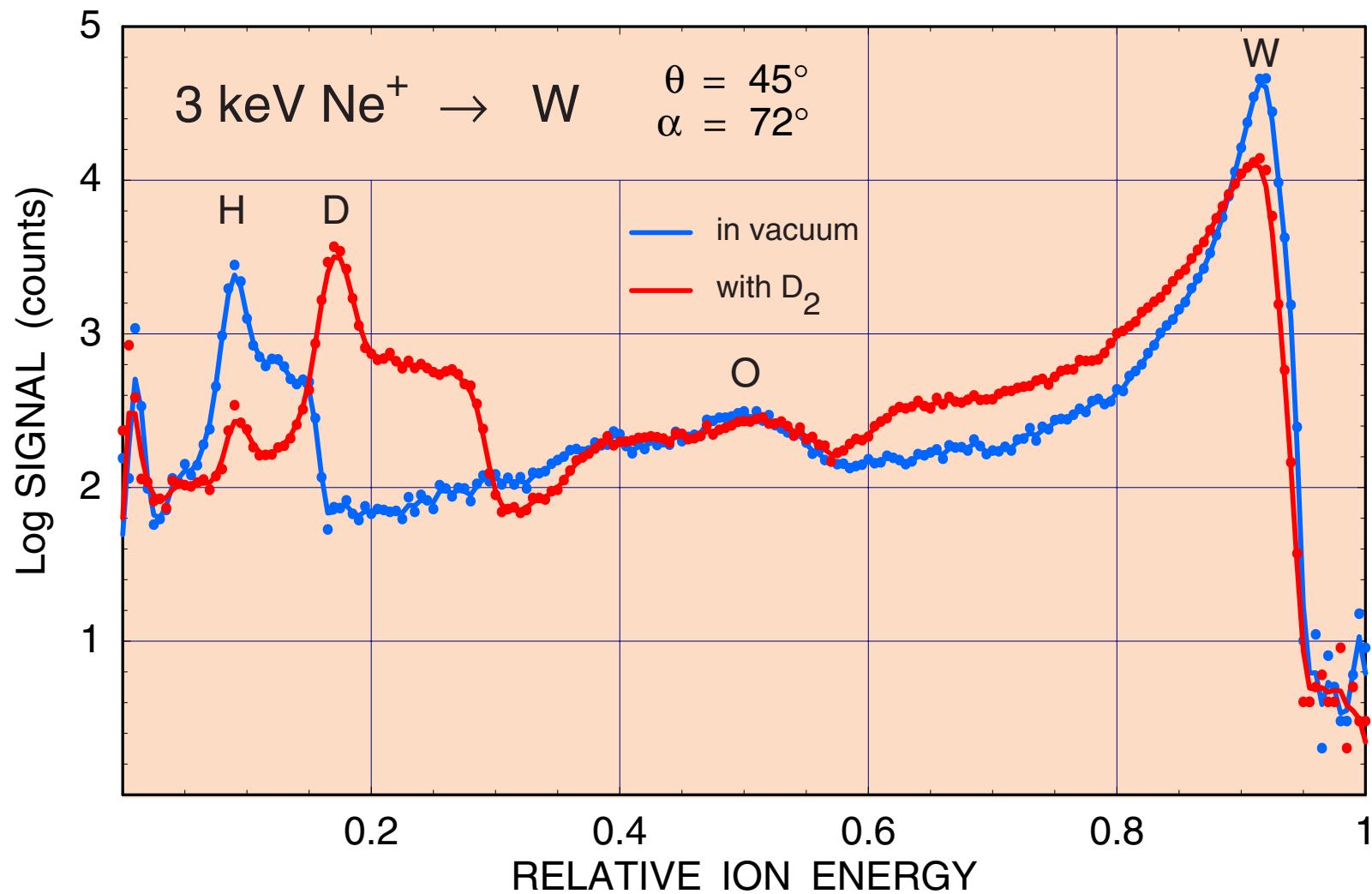
Sn surface stays clean at high temperature.



D_2 does not adsorb on liquid Sn surfaces.



W with H(ads) and D(ads)



Some other interesting properties of liquid Sn

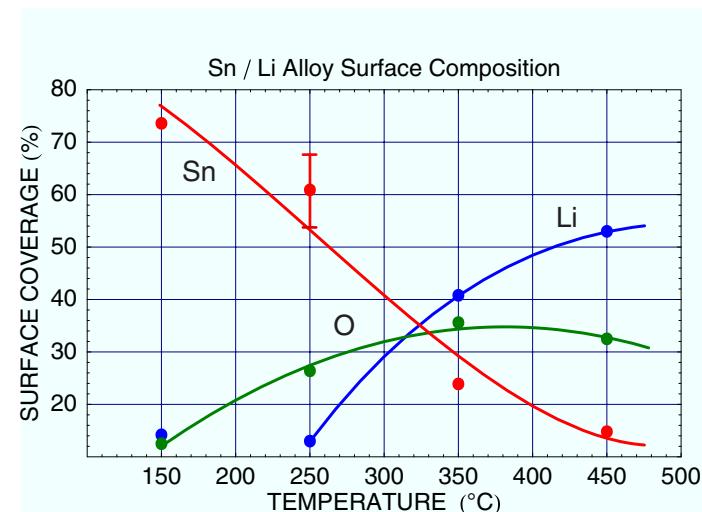
1. Solid hydrides not present in the liquid.

<u>material</u>	<u>melting point (°C)</u>
SnH_4	-146
Li	180.5
Sn	231.93
LiH	688.7

2. Li alloys with Sn and segregates to liquid Sn surfaces.



3. Liquid Sn may trap He.



Summary

- Impurity levels are low on liquid Sn surfaces.
 - In good vacuum, Sn surfaces remain clean from T_m to at least 800 °C.
 - D_2 does not dissociatively chemisorb on liquid Sn.
- ⇒ From a surface perspective, pure liquid Sn appears to be a stable material with nearly constant composition over a wide temperature range.



Future work

- Examine interaction of liquid Sn surfaces with atomic deuterium.
- Study temperature dependence of D adsorption.
- Measure the cross section for ion impact desorption of D from Sn.
- Conduct similar experiments for Ga.

